International Aircraft Materials Fire Test Working Group Meeting

Task Group Session on Revised Cargo Liner Test

Presented to: International Aircraft Materials Fire Test Working Group

By: Tim Salter, FAA Technical Center

Date: June 19-20, 2013, Manchester, UK

Federal Aviation Administration

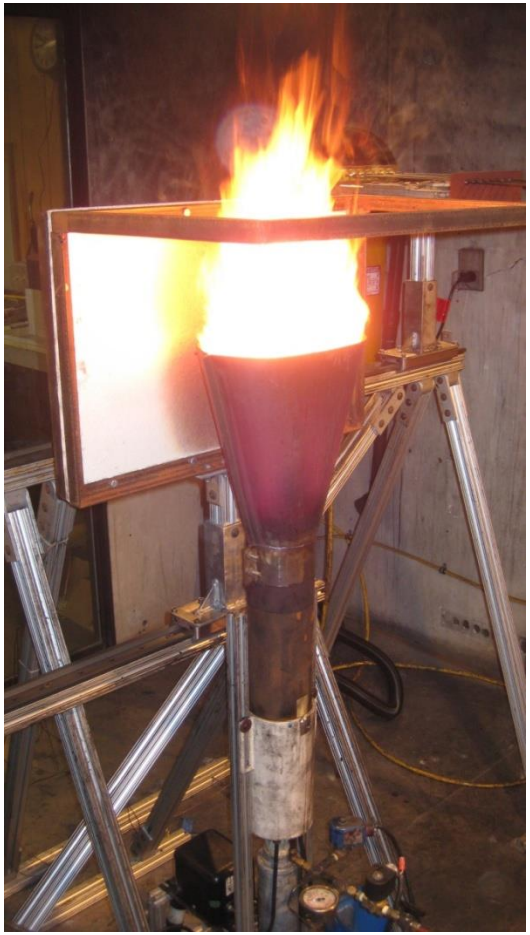
Previous Meeting Items

- **Alternate method of burner air supply plumbing**
  - Not feasible due to negative impact on burner performance
- **Introduction to flame retention head**
- **Initial data results from testing with flame retention head**
- **2012 sonic cargo burner round robin update**
  - Status: completed

Summary for this Meeting

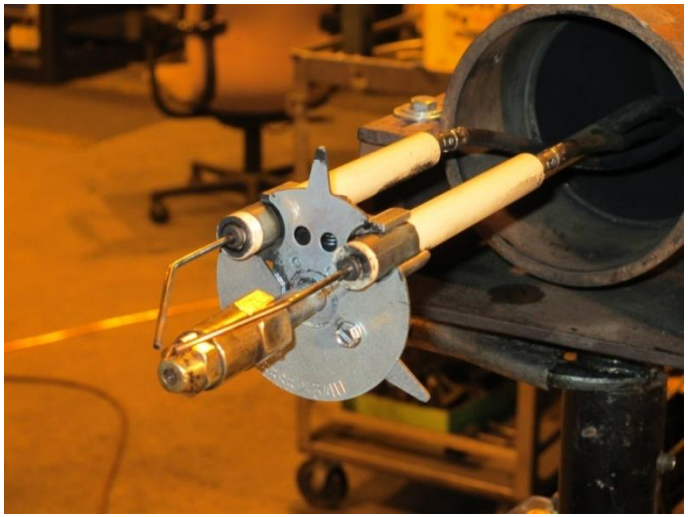
- **Flame retention head**
  - Design and burner assembly
  - Settings
  - Burner development process
  - Data results
- **2013 sonic cargo burner round robin utilizing the flame retention head**
- **Notes on soot removal from burner**

Main Objective: Transition from Park Burner to Sonic Burner



Flame Retention Head (FRH)

- **Replaces stator and turbulator**
- **Fits on end of burner draft tube with minimal modification**
- **Parts purchased from local heating supply store for less than $50**
- **Tests have shown improved repeatability as compared to stator and turbulator configuration**



Function of the Flame Retention Head

- **Flame retention head (FRH) mounts to the end of the burner draft tube**
- **Generates a swirling motion of air and fuel exiting the burner draft tube**
- **Flame burns closer to the burner tube and is more efficient in combusting air and fuel mixture as compared to stator/turbulator setup**

FRH vs. Stator and Turbulator

Flame Retention Head

Stator and Turbulator

Flame Retention Head (FRH) and Static Plate

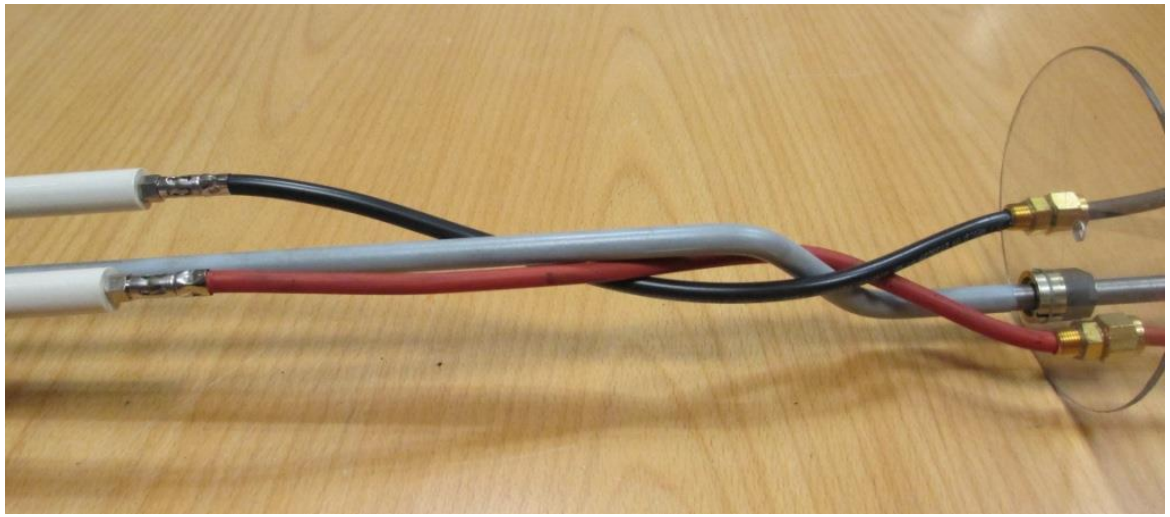
- **F31 Flame Retention Head**
  - Combusts air and fuel mixture in a swirling, efficient flame
  - Replaces turbulator

- **Static Disk**
  - Designed to control and even out air flow to the flame retention head
  - Replaces stator

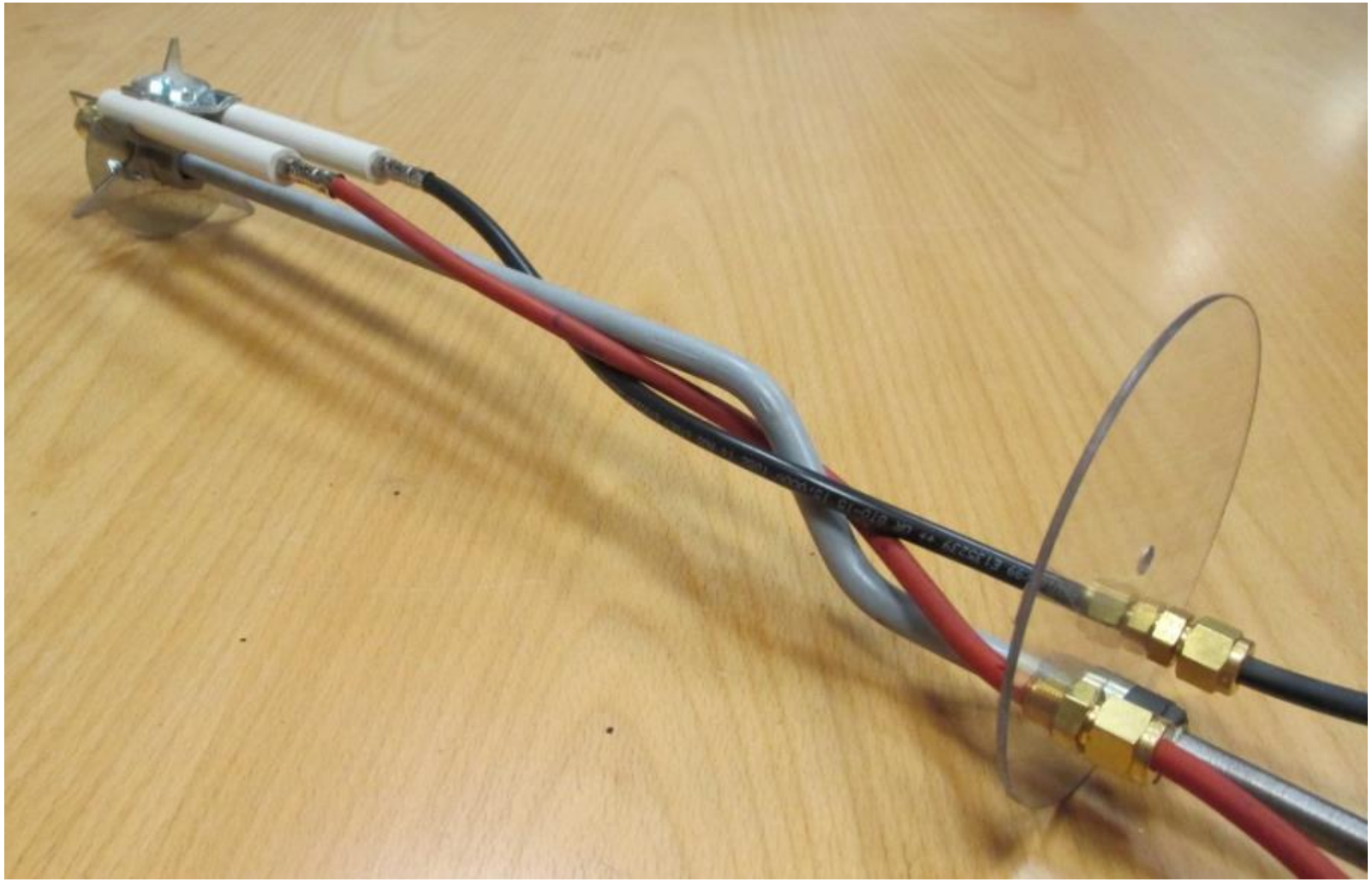
Ignition Wires

- **Wires should be wrapped tightly around fuel rod as shown in picture in order to minimize possible disruptions of airflow inside burner tube**

- **Wire lengths (tip of metal wire terminal to rear of draft tube)**
  - **Red: 12.5”**
  - **Black: 12.5”**

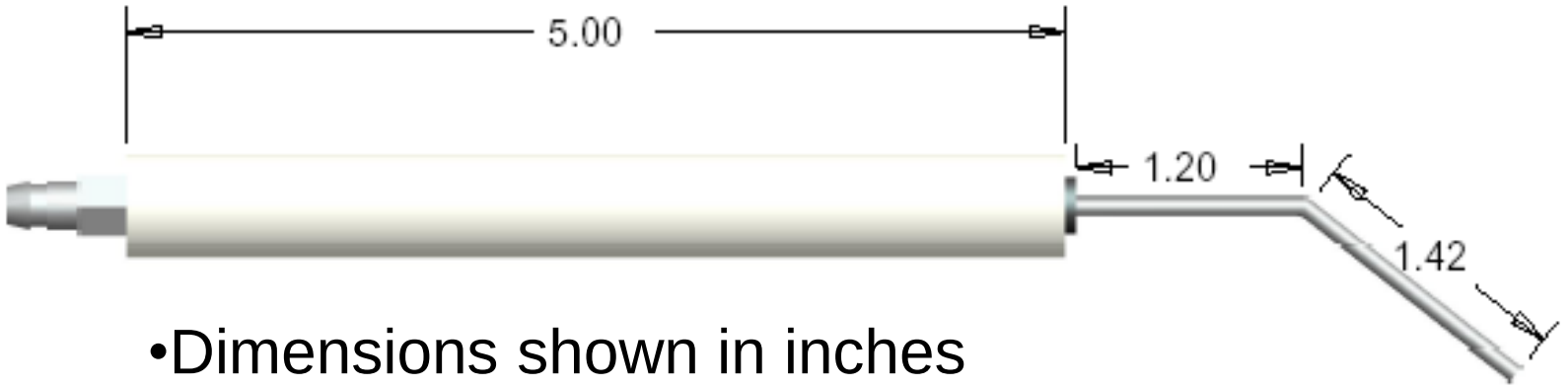


Ignition Wire Routing Method



Igniters

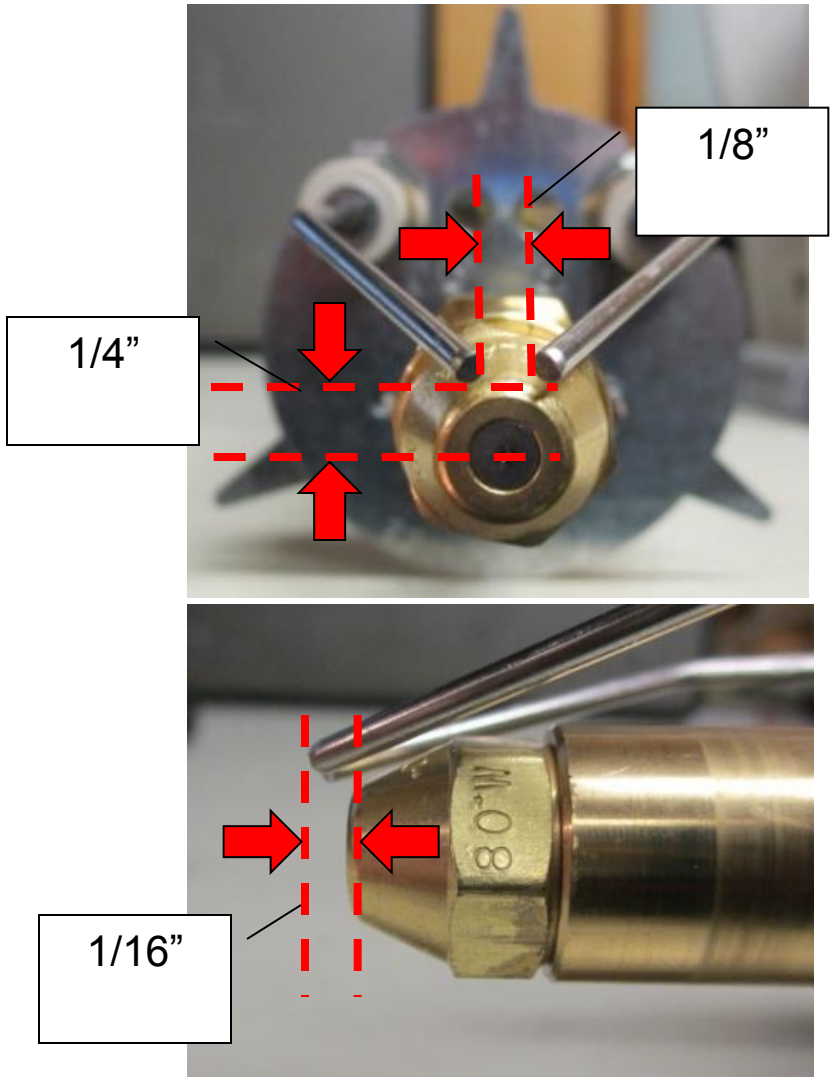
- **Igniter dimensions should be approximately the same as those shown in the pictures below**



•Dimensions shown in inches

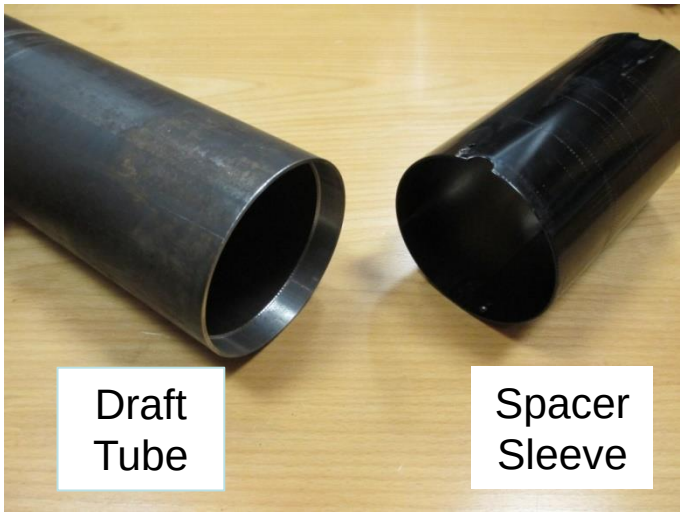
Standardized Igniter Position

- **Gap between igniters**
  - 1/8”
- **Nozzle center to igniters**
  - ¼”
- **Nozzle face to igniter tips**
  - 1/16”



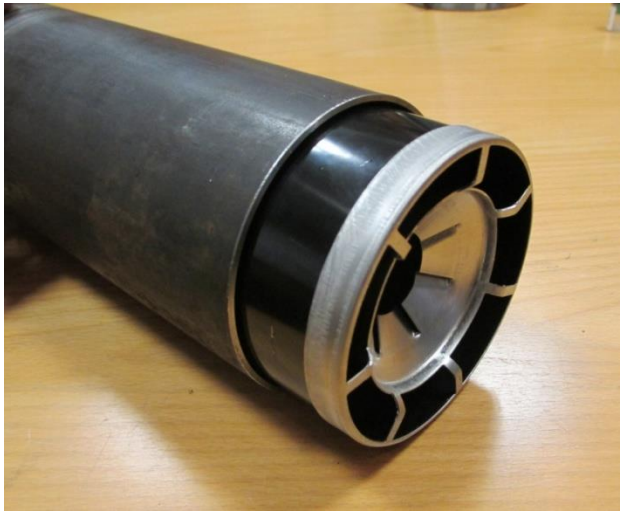
Draft Tube Assembly

- **Top: Modified draft tube shown with machined groove to allow for spacer sleeve and FRH**
- **Bottom: Spacer sleeve fits into draft tube to ensure static plate and fuel rod are centered in draft tube**

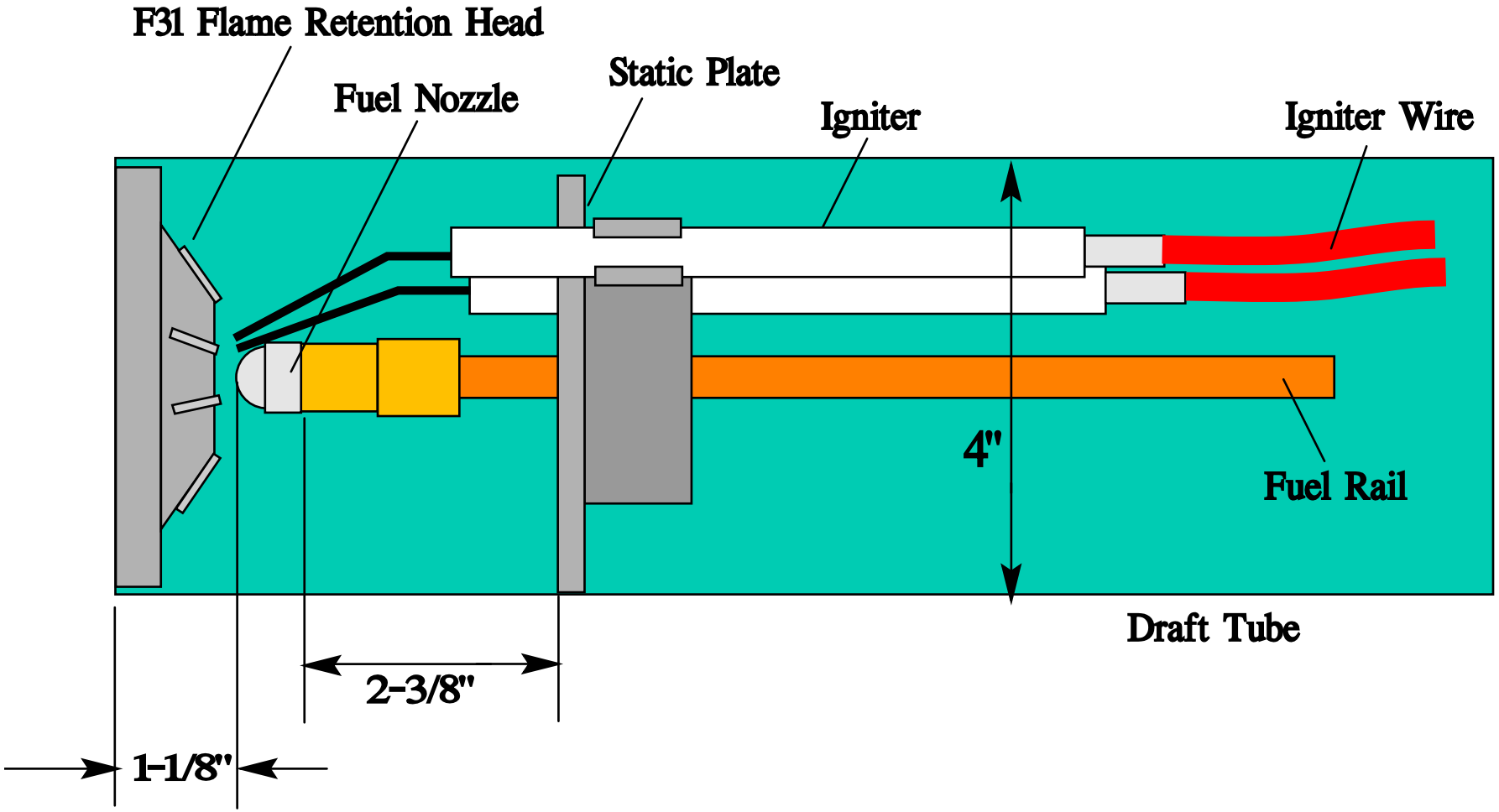


Draft Tube Assembly

- **Top: FRH is press fit onto the spacer sleeve**
- **Bottom: The FRH and spacer sleeve assembly is pressed into the burner draft tube until the face of the FRH and end of the draft tube are flush**

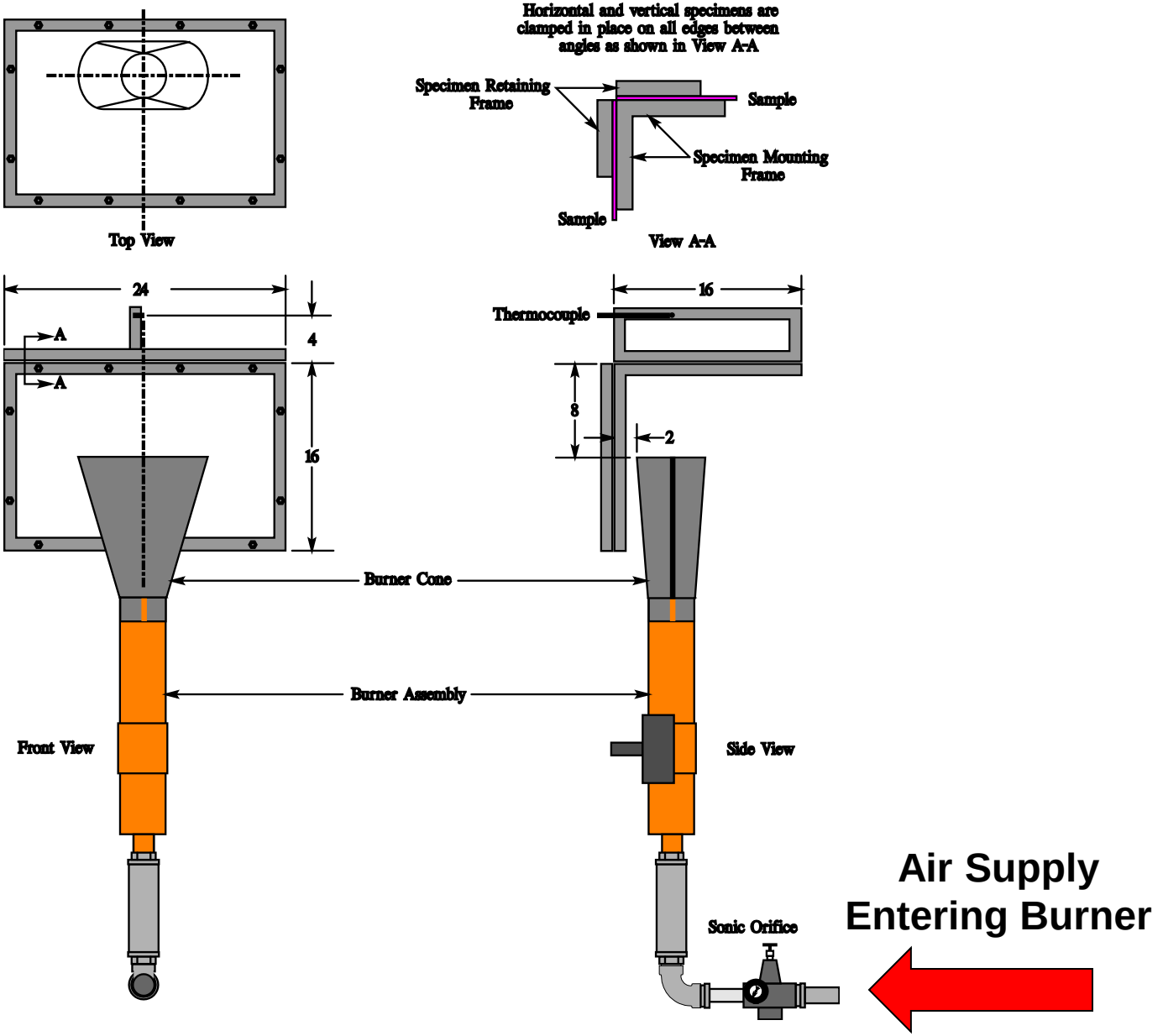


Burner Settings

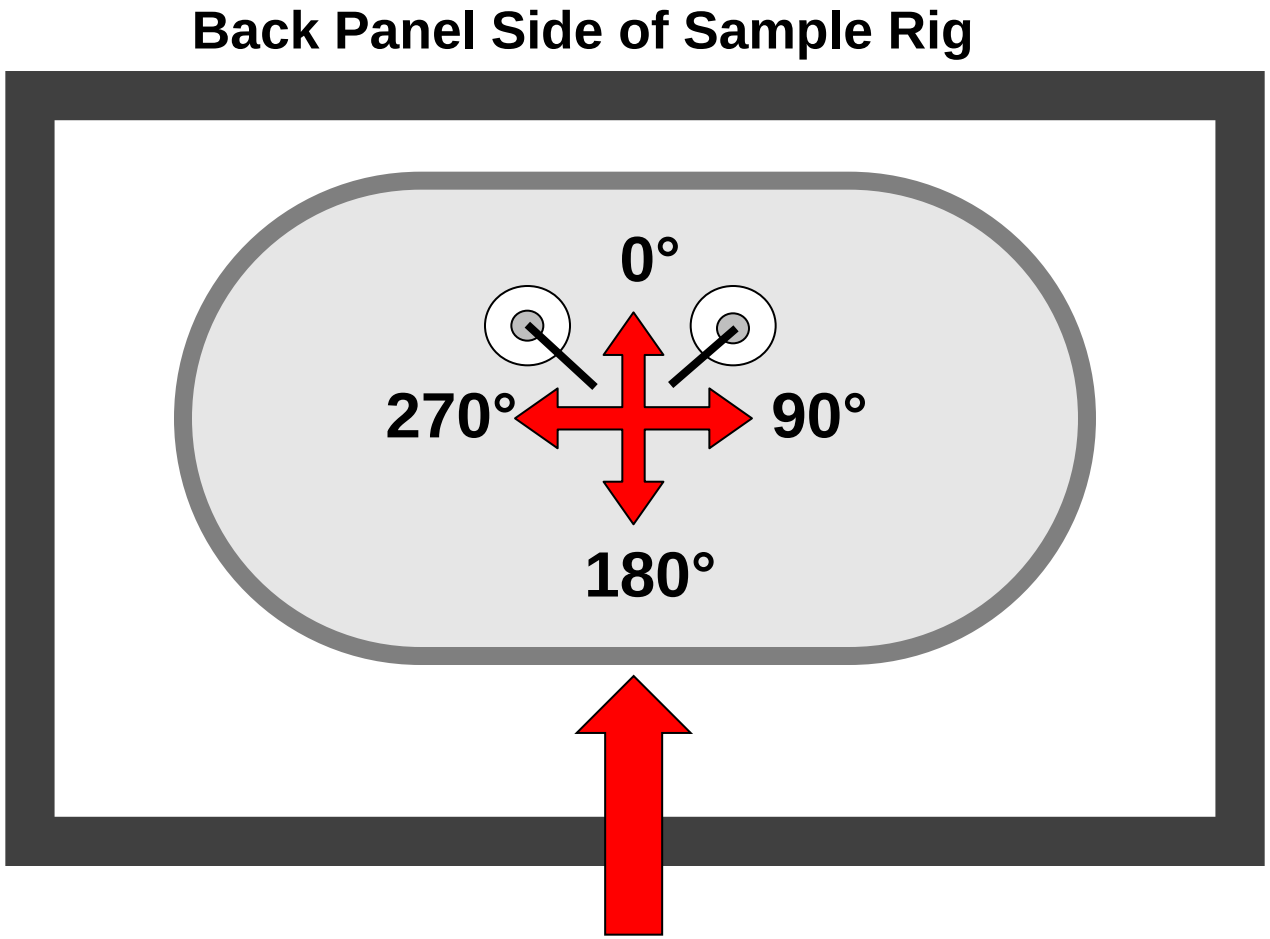


Cargo Liner Burner Settings

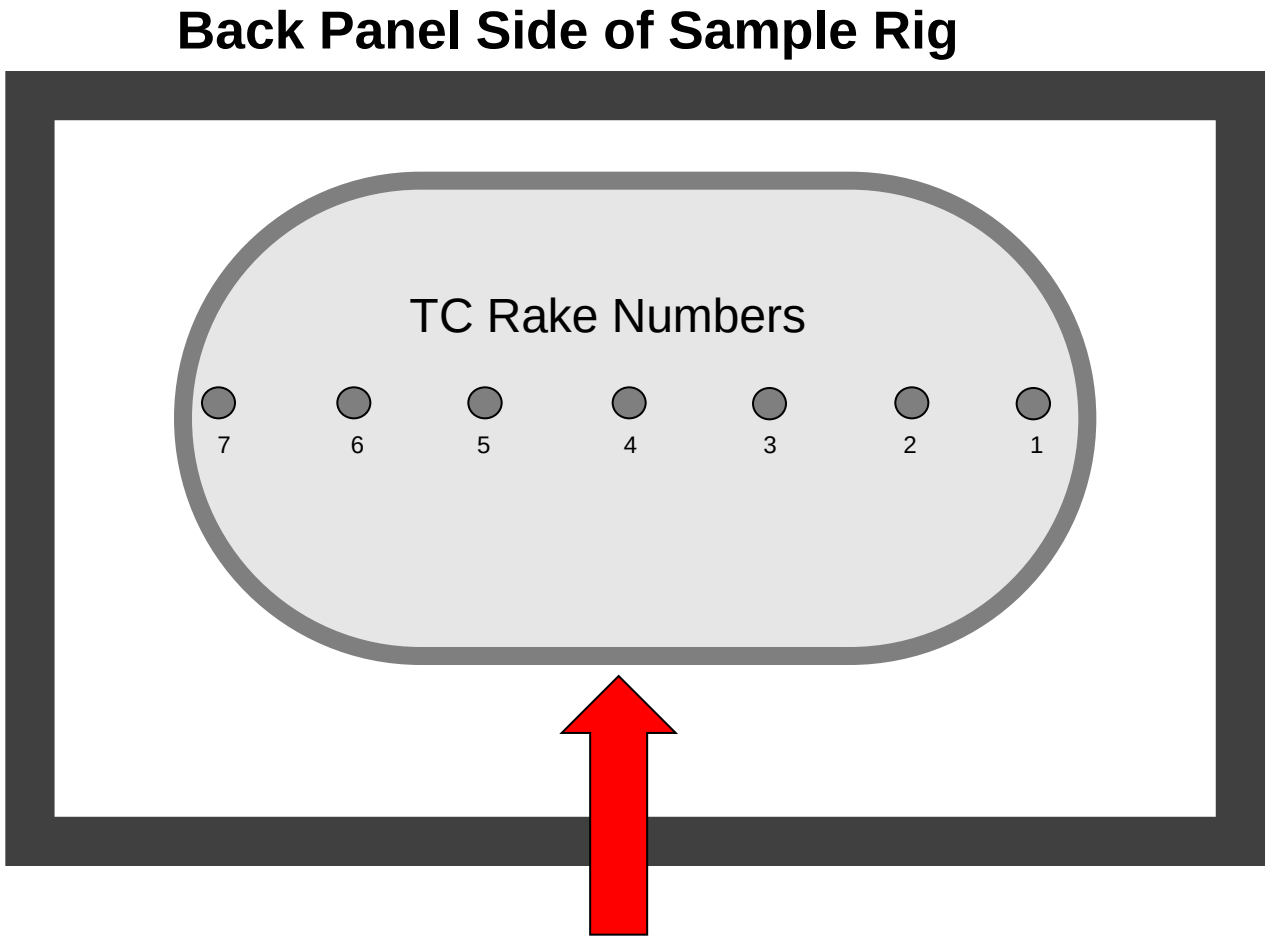
- **Fuel Nozzle:** Delavan 2.0 gal/hr 80° spray pattern W “all purpose”
  Face of FRH to nozzle tip: 1-1/8”
- **Fuel nozzle adapter to static plate: 2-3/8”**
- **Static Plate Angle: centerline of igniters at 0°**
  - Looking into the cone of the burner from above, the centerline between the igniters will be at 0° on the burner reference plane
- **Fuel pressure: 108 psi (+/- 4 psi)**
  - Pressure used as a starting point when checking fuel flow rate
- **Air pressure: 45 psi**
- **Air Temperature: 40-60°F**
- **Fuel Temperature: 32-52°F**


Horizontal and vertical specimens are clamped in place on all edges between angles as shown in View A-A
Specimen Retaining Frame
Sample
Specimen Mounting Frame
Sample
Top View
View A-A
24
4
16
A
A
16
Thermocouple
8
2
Burner Cone
Burner Assembly
Front View
Side View
Sonic Orifice
Air Supply Entering Burner

View from above Burner Cone



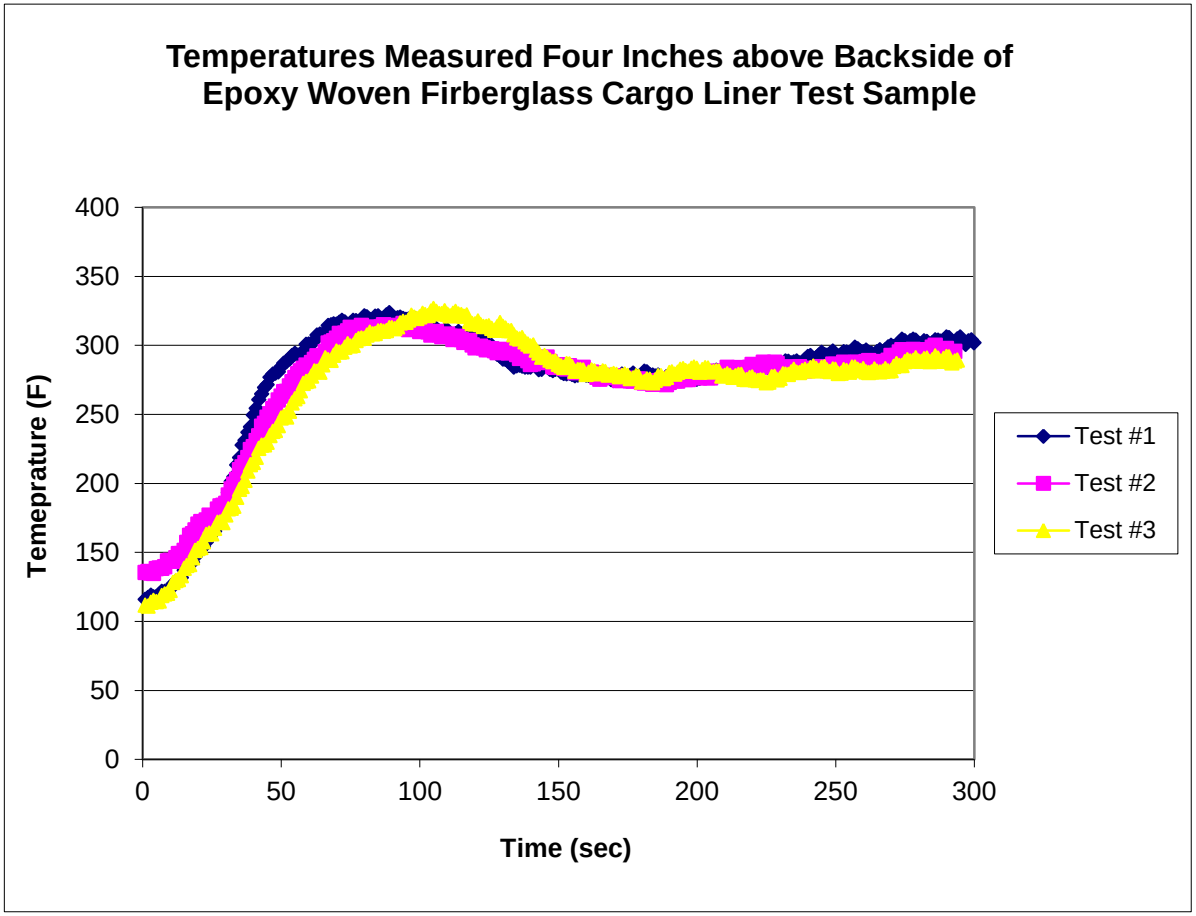
View from above Burner Cone



Development of Burner Settings

- **Began with manufacturer's recommend settings for placement of static plate and igniters**
- **Air pressure**
  - 20, 30 40, 50, 60 psi tested
  - 45 psi chosen based on cargo liner test results
  - Same air pressure used on seat burner with FRH
  - Results appear to be consistent and similar to Park results
- **Nozzles**
  - Delavan B (solid spray pattern)
  - Delavan A (hollow spray pattern)
  - Delavan W (all purpose spray pattern)
  - W nozzle selected based on cargo and seat burner test results

Initial Data Results



Black Felt Burnthrough Test

- 3 samples tested
- Avg Time: 410 sec
- Stdev: 19.4
- %Stdev: 4.73 %

- Stdev and %Stdev improved over tests using stator and turbulator
- Stdev: 22.33
- %Stdev: 6.03 %

2013 Cargo Sonic Burner w/FRH Round Robin

- **2013 round robin for sonic cargo burner currently underway**
- **5 labs currently participating**
  - FAA, Akro Fireguard, Airbus, Accufleet, CAAC
- **FAA has supplied each lab with a fuel nozzle, burner cone, modified draft tube, spacer tube, flame retention head, static plate, and test samples**
- **3 types of samples provided**
  - Heavy, woven fiberglass/epoxy liner (5 pieces)
  - Light, semi-rigid liner (3 pieces)
  - Polyacrylonitrile (PAN) felt (5 pieces)

Provided Burner Parts

- **Modified draft tube**
- **Spacer tube**
- **Static plate**
- **Beckett model F31 flame retention head (FRH)**
- **Delavan 2.0 gal/hr 80° W style fuel nozzle**
- **Burner cone**
  - Included for labs who have not previously participated in a round robin where cones were provided

Cargo Sonic Burner Round Robin

- **Different sample materials will burn through at different rates, or show different temperature profiles measured 4 inches from the back-side of the sample**
- **Results should further reinforce the advantages of using the flame retention head in the sonic burner as an improvement over the stator and turbulator**
- **RR results from participating labs should demonstrate that FRH is a suitable replacement for the stator/turbulator setup**
- **Need RR results in order to finalize burner settings and design**

Soot Removal from Burner

- **Burner cones should be cleaned of soot between each calibration and/or sample test**
- **The compressed air source should remain on during cleaning to reduce the amount of soot that falls into the burner**
- **Fuel may briefly continue to flow from the nozzle after burner shutdown**
- **Soot soaked in fuel may collect in the bottom of the burner and eventually be deposited on the test sample causing premature sample failure**
- **It is important to periodically inspect and remove any buildup of soot from within the bottom of the burner tube**
- **A small shop vacuum works well to clean most of the soot from the bottom of the burner without the need to disassemble the burner**

Soot Removal from Burner

Soot buildup in burner

Removing soot with vacuum

Planned Activities

- **Finalize FRH burner settings**
- **Continue with 2013 sonic cargo burner RR using the flame retention head**
- **Conduct testing of various cargo design features to support development of advisory material**
- **Test burner using heat sink on thermocouples**
  - Prolong life of thermocouples, prevent inaccurate readings

Questions?